SLOTT-AGAPE DATA PROCESSING

G. IOVANE
Dipartimento di Scienze Fisiche "E.R.Caianiello", Universitá di Salerno, Italy
E-mail: geriov@sa.infn.it

MEDEA Program (**M**icrolensing **E**xperiment **D**ata-Analysis Software for **E**vent with **A**mplification) is here presented. It is developed to the pixel lensing analysis used by SLOTT-AGAPE (**S**ystematic **L**ensing **O**bservation at **T**oppo **T**elescope - **A**ndromeda **G**ravitational **A**mplification **P**ixel **E**xperiment) Collaboration. All software components are fully automated and they can be used on-line and off-line.

1 Gravitational lensing and pixel lensing technique

In the recent surveys [1] monitoring millions of stars much attention has been focused on the possibility that a relevant fraction of galactic dark matter could consist of MACHOs (Massive Astrophysical Compact Halo Object). In order to detect them, it was proposed by Paczynski (1986) to search for dark objects by gravitational lensing [2]. In fact, when a compact object passes near the line of sight of a background star, the luminosity of this star increases giving rise to a characteristic luminosity curve.

In a dense field, many stars contribute to any pixel of the CCD camera at the focal point of the telescope. When an unresolved star is sufficiently magnified, the increase of the light flux can be measured on the pixel. Therefore, instead of monitoring individual stars, we follow the luminous intensity of the pixels. Then all stars in the field, and not the only few resolved ones, are candidates for a microlensing event. Of course, only the brightest stars will be amplified enough to become detectable above the fluctuations of the background, unless the amplification is very high and this occurs very seldom. In a galaxy like M31, however, this is compensated by the very high density of stars.

If ϕ is the amplified flux detected by the pixel and ϕ_B the one of the background, the flux variation is given by

$$\phi_{star}(A-1) = \phi - \phi_B \tag{1}$$

and

$$\phi_B = \phi_{star} + \phi_{others} \tag{2}$$

where ϕ_{star} is the star flux at rest (i.e., when it is not lensed) and ϕ_{others} is the flux of the stars in the same pixel. A is the amplification

$$A = \frac{x^2+2}{x\sqrt{x^2+4}} \qquad with \qquad x^2 = \omega^2(t-t_0)^2 + x^2_{\min}, \tag{3}$$

where $\omega = t_E^{-1}$ is the inverse Einstein time; $x_{\min}$ is the impact parameter in units of the Einstein radius R_E, and t_0 is the time of maximum amplification.

2 MEDEA Software

2.1 Conceptual Design for data acquisition, selection and analysis

A two level trigger follows the data acquisition to perform the on-line selection of interesting events that can be studied quasi-on-line. Other events, which should be more complicate lensing events, variable stars, novae and supernovae and so on, are not lost during the selection, but are stored for an off-line analysis.

More in particular thanks to the first trigger level light curves with luminosity variation are selected; while the second trigger level is responsible of lensing event selections [3].

2.2 MEDEA Components

The software system is made by different units:

- The Intelligent Data Acquisition **(I-DAQ)** Unit, that is responsible of the data acquisition and technical corrections.
- The Control Unit, which thanks to Telescope Control System (**TCS**), controls the telescope by following the instruction from the DataBase Control System (**DBCS**) or console.
- The DataBase (**DB**) Unit is the intelligent part of the system; in fact, here we have the data storage and processing. Such a unit is the natural link from the observations to the data analysis components.
- The Processing and Analyzing (**P&A**) Unit is the platform where the massive data analysis is performed. It is made of three main sub-units:
  - Data pre-processing sub-unit, (**P&A**).(**DAPP**), used for geometrical alignment, photometric calibration, and seeing correction;
  - Data processing sub-unit, (**P&A**).(**DAP**), is the first trigger level, that selects amplified light curves by using a specific peak detection algorithm;
  - Data analysis sub-unit, (**P&A**).(**DAU**), used for testing different lensing model (single point-like lens and source, double source, extended source), for performing color correlation test, and for verifying the statistical Kolmogorov-Smirnov test and Durbin-Watson one.

References

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2. Paczynski B., ApJ 304,1 1986.
3. Capozziello S. and G.Iovane, AstroTech J.vol.2 - Number 1-1999.